DISEASE MANAGEMENT IN WILDLIFE

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Abstract - Management of disease in wild animals may be done because the disease is having a negative effect on a valued species, because the disease is a risk to humans or domestic animals, or because there is public pressure to "do something" about a perceived problem. Management may take four general directions: a decision might be made not to intervene, in which case the disease will continue; or intervention could be directed at preventing disease occurrence, reducing the frequency or impact of the disease, or complete eradication of an existing condition. Within these general directions, effort might be directed at attacking the disease agent, altering the environment, manipulating the host population, or changing human activities. Most programs involve some combination of techniques that includes public education. Disease management requires input from many disciplines; the system used in Canada to link veterinary and wildlife management expertise through the Canadian Cooperative Wildlife Health Centre is described.

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This paper is intended to give an overview of general methods that might be used to manage or manipulate disease in wild animals. Examples will include infectious and non-infectious diseases, with emphasis on conditions that occur in North America. Discussion of examples will necessarily be brief.

There are four basic reasons why one might attempt to manage disease in a wild species:

i. because the disease is having a serious negative effect on a valuable wild species.

For instance, managers in North America have been attempting to manage wild mountain sheep *Ovis canadensis* for many years, to reduce serious losses from pneumonia that have devastated some populations. Similarly, management of disease, particularly canine distemper and plague, have become an important component of the recovery plan for the endangered black-footed ferret *Mustela nigripes*. Management for canine distemper is necessary because ferrets are very susceptible to this disease, and for plague because prairie dogs *Cynomys* spp., the principal prey of ferrets, may be wiped out over large areas by plague.

ii. Because disease in wild animals is a risk to human health.

Two important diseases of this type in North America are rabies, carried by a number of different carnivores, and the hantaviruses carried by some wild rodents that cause Hantavirus Pulmonary Syndrome, a severe form of pneumonia in humans.

iii. Because disease in wild animals is a risk to domestic animals.

An example of this type of problem in North America is the occurrence of both *Mycobacterium bovis* and *Brucella abortus* infection in wild bison *Bison bison* in and around Wood Buffalo National Park in northern Canada. The occurrence of these diseases in bison is important, because both diseases have been eradicated from cattle throughout Canada after a decades long, expensive struggle. The bison now represent a potential reservoir of infection for other herds of disease-free bison, cattle and humans.

iv. Because there is public pressure to "do something" about a disease in wildlife.

A current example of this type in North America is pressure, primarily from organized hunting groups, to manage avian botulism in wild waterfowl. Botulism kills many ducks each year in western Canada and the USA, but the actual impact of the disease on duck populations is unknown, so it is unclear that management is required. At present, management consists of collecting and disposing of dead birds during outbreaks. Large amounts of money are spent each year on this "carcass cleanup" but, while it meets the objective of "doing something", there is no firm evidence that removal of carcasses reduces losses or has any population effect.

If disease management is contemplated, there are four basic strategies that might be considered:

1. **"Do nothing"**. Deciding not to pursue active management of a disease should be a conscious decision, reached after reviewing the reasons for possible management and the probability of success of different methods. A deci-

sion to do nothing, *i.e.*, not to interfere, is appropriate in many situations. However, if nothing is done it must be recognized that the disease will likely continue to occur.

2. **Prevention.** The most obvious examples of prevention are situations in which measures are taken to prevent a disease from gaining entry into an area. For example, a nematode *Parelaphostrongylus tenuis*, the "meningeal worm" of white-tailed deer *Odocoileus virginianus*, is very common in deer in eastern North America but is not present in western regions. The parasite does not harm white-tailed deer, but causes fatal neurologic disease in other cervids, including moose *Alces alces*, wapiti *Cervus elaphus*, mule deer *O. hemionus* and caribou *Rangifer tarandus*, as well as mountain sheep. All of these species would be at risk if the parasite were to become established in western Canada. The most likely method by which this parasite would move westward is through translocation of infected deer. To prevent this, provinces in western Canada prohibit importation of deer from areas where the parasite occurs.

Unfortunately, many diseases of wild animals have been translocated around the world because of inadequate preventive measures. For example, the liver fluke *Fascioloides* magna was introduced to Europe with wapiti from North America, and nematodes of the genus *Elaphostrongylus* were introduced from Europe to New Zealand with red deer, and to Newfoundland with reindeer. Despite better testing methods, and greater awareness of the potential problems, many translocations of wildlife continue to occur without any consideration of the likelihood of introducing new disease agents. Some such parasite introductions have occurred despite rigorous testing of individual animals and treatment with drugs.

The opposite side of this problem also may occur when susceptible animals are introduced into an area where a disease is already present. Caribou are very susceptible to *Protostrongylus tenuis*, but a few years ago caribou were translocated from Newfoundland (where P. *tenuis* does not occur) to Maine (where the parasite is enzootic in white-tailed deer). Predictably, the introduction failed and at least some of the introduced caribou died of P. *tenuis* infection.

3. **Control.** The objective in a disease control program usually is to reduce the frequency of occurrence or the severity of a disease to a tolerable or acceptable level, rather than to eliminate the disease entirely. Insecticides kill many wild birds but, because insecticides are so important for crop production throughout the world, it is not feasible to stop all insecticide use or to eliminate poisoning completely. Control programs aimed at this problem are directed toward reducing use of insecticides where possible, development of less toxic and less persistent insecticides, and education of those who use insecticides, so that the chemicals are used in ways that reduce the risk to birds.

4. **Eradication or complete elimination of a disease.** Very few diseases of wild animals have been eradicated, even on a local level. One successful program, that involved killing thousands of deer, may have lead to the elimination of foot-and-mouth disease from deer in California during the early 1920's. The current program in North America and elsewhere to prohibit the use of lead shot for waterfowl hunting, and the use of lead sinkers for fishing, is an attempt to eradicate lead poisoning of waterbirds. (The assumption is that when use of lead for these purposes ceases, lead pellets currently in wetlands will become buried and unavailable to birds). A similar ban on the use of mercurial compounds for treating seed grains eliminated a problem of mercury poisoning of terrestrial seed-eating birds in Sweden.

Within these basic strategies, a disease may be attacked by dealing with the causative agent or factor, by altering the environment, by manipulating the host population, or by changing some aspect of human activities that will influence the disease.

The most obvious way to manage a disease is by dealing directly with the causative agent. In the case of infectious disease, the agent might be attacked either within the host animal (for example by antibiotic treatment) or when it is outside the host animal. Dealing with disease agents within the host is a standard method in both human and domestic animal medicine. There is no reason to think that treatments, such as antibiotics or anthelmintics, would be less successful in individual wild animals than in domestic animals; however, there are great difficulties in delivering drugs to free-ranging animals. Treatment with anthelmintics has been used on a limited basis to reduce transplacental transmission of *Protostrongylus* spp. lungworms in wild mountain sheep. This resulted in better lamb survival, but it did not address the underlying problem of high sheep density on overcrowded range. Similarly, we have used acaricides to treat heavy infestations of ticks on nestling falcons on a very limited basis. In

general, it appears that treatment may be suitable for individual animals, or small groups under unusual circumstances, but treating individuals has very limited usefulness as a measure for dealing with disease in wild populations.

Another method is to prevent or reduce exposure of animals to the disease agent. In North America, outbreaks of avian cholera and avian botulism in waterfowl are often managed by disposal of the carcasses of dead birds. In the case of avian cholera, the objective is to remove carcasses as a source of *Pasteurella multocida*, and in botulism the goal is to remove carcasses that act as substrate within which *Clostridium botulinum* may toxin. While this type of management seems appropriate intuitively, there is no evidence that carcass collection alters the course of either disease or reduces mortality. Preliminary studies in botulism outbreaks suggest that only a small proportion of the carcasses present are actually removed during these carcass collections. Use of disinfectants or other chemicals to destroy disease agents in the environment has received little attention in wild animals, and is probably of very limited usefulness, except in very local situations.

The most promising area for disease management in wild animals is through environmental alteration to reduce exposure of animals to disease agents. The goal of such manipulation might be to change the distribution of the disease agent, or the host, or to alter the environment in some way that reduces contact or transmission. A simple example of such environmental manipulation is alteration of the design of electrical transmission lines to prevent large birds, such as eagles and vultures, from becoming electrocuted. Similarly, transmission lines can located away from known bird flight paths, to reduce the number of deaths from collisions by large birds such as swans. An environment can also be altered to reduce exposure of animals to an infectious agent. On Isle Blanche, an island in the Saint Lawrence River in eastern Canada, nesting common eiders *Somateria mollisima* died of avian cholera in most years. We found that water in shallow pools, under dense vegetation on the island, contained large numbers of the causative bacterium *Pasteurella multocida*. Birds were exposed repeatedly to bacteria as they walked through the pools going to and from their nests. Clearing the dense vegetation and drainage of the standing water has reduced the occurrence of avian cholera on this island. Unfortunately, using environmental manipulation to manage a disease requires detailed knowledge of the ecology of the disease; something that is often missing for disease conditions in wild animals.

Disease may be managed by manipulating the host population. The objective may be to reduce exposure of animals to a disease agent, to reduce host density and disease transmission, or to increase the resistance of the host population. One direct method of manipulating the host population is to move animals away from a source of disease. During an outbreak of avian cholera among ducks on a large saline lake, we found that mortality was concentrated where small freshwater streams entered the lake, and that the water at these sites contained many *P. multocida*. Birds were discouraged from using these areas by propane exploding noise makers. (Attempts to move wild animals often fail because of intense loyalty to the area, and rapid habituation by the animals to devices used to scare them away). Attempts to control disease in wild animals by reducing population density over large areas have generally been unsuccessful, because of the inability to achieve or maintain sufficient population reduction over time. Population reduction has occasionally been successful in preventing the movement of a disease, but this has depended on a large sustained effort in a relatively small area. Rabies among striped skunks *Mephitis mephitis* swept steadily westward across the Canadian prairies during the 1950's and 1960's, reaching the border of province of Alberta by about 1970. The disease has been prevented from spreading into Alberta by rigorous skunk depopulation within a 30 km band along the border. Occasional cases of rabies that do occur beyond this zone are dealt with by skunk depopulation in a circular zone around the case.

Another way of altering the host population is to increase the level of resistance to disease within the population. This is done most directly through immunization. Early attempts at immunization were often unsuccessful, primarily because of difficulty in delivering vaccine to the animals. For instance, when anthrax occurred in wild bison in northern Canada about 30 years ago, an attempt was made over several years to collect and vaccinate the animals to reduce losses. However, immunization had no significant effect, because only a small proportion of the herd could be captured for immunization at any time, and the vaccine induced only short-term immunity. In contrast, oral vaccination pro-

grams have been highly successful in reducing the occurrence of rabies among foxes in both Europe and Canada, but these have required massive effort to deliver vaccine to the animals. It is not clear that this type of massive effort can be sustained when the disease becomes very rare and attracts little public concern.

Almost every attempt to manage a disease in wild animals involves changing human activities in some way. I have alluded to several examples earlier, including altering how and where electrical transmission lines are constructed, changing how people hunt and fish to reduce lead poisoning of birds, and changing the way that farmers use insecticides to reduce poisoning of birds. Education is an important part of many disease management programs. Brucellosis, caused by *Brucella suis* biovar 4, is a relatively common infection in wild caribou in northern Canada and is also a serious zoonotic disease. Caribou are very important in the diet and culture of Inuit people. The disease can not be controlled in free-ranging caribou, so management has been directed toward educating the people, so that they can continue to utilize caribou but recognize and avoid exposure to infected animals. Another example, of the use of education for disease management, is training field staff and biologists in proper methods for capturing and handling wild animals to reduce the occurrence of capture myopathy. Most successful disease management plans have included some form of public education.

An essential component of any attempt to manage a disease must be a system for measuring the effectiveness of the management. The goal should be adaptive management, in which useful portions of the plan are continued and expanded, and the unsuccessful aspects are terminated. Very few disease management techniques in wildlife have been assessed critically. The actual value of common practices, such as limited population reduction and carcass sanitation, in changing the outcome of disease are unknown.

Disease management requires input from specialists in many disciplines. In Canada, veterinary medical expertise has been linked with wildlife management expertise through formation of the Canadian Cooperative Wildlife Health Centre (CCWHC) in 1992. This is a partnership among Canada's four veterinary colleges that is supported financially by Environment Canada, the wildlife resource departments of all provinces and territories, and other organizations including Ducks Unlimited Canada, and the Canadian Wildlife Federation. The CCWHC is actively involved in disease surveillance, with each veterinary college providing disease diagnostic service to a region of Canada, as well providing consultation and training on wildlife disease issues. The CCWHC maintains a national data base of wildlife health problems in Canada that is available to its supporters, and publishes a newsletter describing current wildlife health concerns. The CCWHC is not a research organization but it assists supporting agencies with disease investigation, and wildlife health problems identified through CCWHC become research programs for graduate students within the veterinary colleges, so that a number of faculty are involved with wildlife health at each veterinary college.